INTERNATIONAL STANDARD

ISO 4892-3

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Plastics — Methods of exposure to laboratory light sources —

Part 3:
Fluorescent UV lamps

Plastiques — Méthodes d'exposition à des sources lumineuses de laboratoire —

Partie 3: Lampes fluorescentes UV

Reference number
ISO 4892-3:1994(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 4892-3 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 6, *Ageing, chemical and environmental resistance.*

Together with the other parts of ISO 4892, it cancels and replaces ISO 4892:1981, which has been technically revised.

ISO 4892 consists of the following parts, under the general title *Plastics — Methods of exposure to laboratory light sources*:

— *Part 1: General guidance*

— *Part 2: Xenon-arc sources*

— *Part 3: Fluorescent UV lamps*

— *Part 4: Open-flame carbon-arc lamps*

Annex A of this part of ISO 4892 is for information only.

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Plastics — Methods of exposure to laboratory light sources —

Part 3:
Fluorescent UV lamps

1 Scope

This part of ISO 4892 specifies methods for exposing specimens to different types of fluorescent UV lamp. General guidance is given in ISO 4892-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4892. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 4892 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4582:1980, *Plastics — Determination of changes in colour and variations in properties after exposure to daylight under glass, natural weathering or artificial light.*

ISO 4892-1:1994, *Plastics — Methods of exposure to laboratory light sources — Part 1: General guidance.*

ISO 4892-2:1994, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc sources.*

CIE 85:1989, *Technical Report — Solar spectral irradiance.*

3 Definitions

For the purposes of this part of ISO 4892, the following definitions apply.

3.1 fluorescent UV lamp: A fluorescent lamp in which radiant emission in the ultraviolet region of the spectrum, i.e. below 400 nm, makes up at least 80 % of the total light output.

3.2 type I fluorescent UV lamp: A fluorescent UV lamp in which radiant emission below 300 nm is less than 2 % of the total light output. These lamps are commonly called UV-A lamps.

3.3 type II fluorescent UV lamp: A fluorescent UV lamp in which radiant emission below 300 nm is more than 10 % of the total light output. These lamps are commonly called UV-B lamps.

4 General requirements

4.1 Specimens are exposed to fluorescent UV lamps under controlled environmental conditions. There are several different types of fluorescent UV lamp (see 3.1 and 3.2). UV-A lamps or combinations of UV-A lamps are recommended. When combinations of lamps with different spectral emissions are used, provision shall be made to ensure uniformity of the spectral irradiance at the surface of the specimens, e.g. by continuous repositioning of the specimens around the lamp array.

4.2 Fluorescent UV lamps use the emission from a low-pressure mercury arc to excite a phosphor that produces a continuous spectrum in a relatively narrow wavelength interval, which is generally distributed about a peak wavelength. The spectral distribution of the radiation from a fluorescent lamp is determined by the emission spectrum of the phosphor and the UV transmission properties of the glass tube. Fluorescent UV lamps are generally used to expose material to UV radiation in a limited spectral range.

4.3 The procedure may include measurement of the irradiance and radiant exposure at the surface of the specimen.

4.4 It is recommended that a similar material of known behaviour be exposed simultaneously with the experimental material as a reference.

4.5 Comparison of results obtained from specimens exposed in different types of apparatus should not be made unless reproducibility has been established among the various types of apparatus for the material to be tested.

5 Apparatus

5.1 Laboratory light source

5.1.1 Type I lamps are available with a choice of spectral distribution of radiation and vary significantly. The more common may be identified as UV-A 340, UV-A 351, UV-A 355 and UV-A 365, these designations representing the characteristic wavelength (in nanometres) of the peak emission. Of these, the UV-A 340 simulates daylight from 300 nm to 340 nm better than any other fluorescent UV lamp. When combinations of lamps with different spectral emissions are used, provision shall be made for the uniformity of the spectral irradiance at the surface of the specimens, e.g. by continuous repositioning of the specimens around the lamp array.

5.1.2 Type II lamps have a spectral distribution of radiation which peaks near the 313 nm mercury line. They emit significant amounts of radiation below 300 nm, the nominal cut-off wavelength for solar radiation, which may result in ageing processes not occurring outdoors. Type II lamps may be used by agreement between the parties concerned. Such agreement shall be stated in detail in the exposure report.

5.1.3 Many fluorescent lamps age significantly with extended use. Follow the apparatus manufacturer's instructions on the procedure necessary to maintain the desired irradiance.

5.2 Exposure chamber

5.2.1 The design of the exposure chamber may vary, but it shall be constructed from inert material and provide uniform irradiance in conformance with 5.1.3, with means for controlling the temperature. When required, provision shall be made for the formation of condensate or spraying water on to the exposed face of the specimen, or controlling the humidity in the exposure chamber.

5.2.2 Specimens shall be mounted so that the exposed face is located in the plane of uniform irradiance and is not within 160 mm of the ends of the lamps or within 50 mm of the edge of a flat lamp array. Lamp replacement, lamp rotation and specimen rearrangement may be required to obtain uniform exposure of all specimens to UV radiation and temperature. Follow the manufacturer's recommendations for lamp replacement and rotation.

5.3 Radiometer

The use of a radiometer to monitor irradiance and radiant exposure is optional. If a radiometer is used, it shall conform to subclause 5.2 of ISO 4892-1:1994.

5.4 Black-standard/black-panel thermometer

Black-standard thermometers or black-panel thermometers shall conform to subclause 5.1.5 of ISO 4892-1:1994.

5.5 Exposure to moisture

5.5.1 In apparatus designed to wet the exposed faces of the specimens by means of a humidity-condensing mechanism, the water vapour shall be generated by heating water in a container located beneath and extending across the whole area occupied by the specimens. The specimen racks completely filled with specimens constitute the side wall of the exposure chamber, so that the backs of the specimens are exposed to the cooling effect of the ambient room air.

5.5.2 When apparatus not conforming to 5.5.1 is used, means may be provided for controlling the relative humidity within the exposure chamber, for spraying the specimens with pure water or an aqueous solution simulating acid rain or for producing condensation. Spray water shall conform to subclause 4.6 of ISO 4892-2:1994.

5.6 Specimen holders

Specimen holders shall be made from inert materials that will not affect the results of the exposure. The behaviour of specimens can be affected by the presence of backing and the backing material used. The use of backing shall therefore be by mutual agreement between the interested parties.

5.7 Apparatus to assess changes in properties

The apparatus required by the International Standards relating to the determination of the properties chosen for monitoring (see also ISO 4582) shall be used.

6 Test specimens

Refer to ISO 4892-1.

7 Exposure conditions

NOTES

1 The surface temperature of the specimens is a crucial exposure parameter. Generally, degradation processes run faster with increasing temperature. The specimen temperature permissible for accelerated exposure depends on the material under test and on the ageing criterion under consideration.

2 Fluorescent UV lamps emit relatively little infrared radiation when compared to xenon-arc and carbon-arc sources. In fluorescent UV apparatus, heating of the specimen surface is primarily by convection of heated air across the panel. Therefore, the difference between the temperature of a black-panel thermometer, a black-standard thermometer, the specimen surface and the air in the test chamber is minimal.

7.1 General

The following two modes of exposure are recommended. They correspond to the apparatus described in 5.5.1 (exposure mode 1) and 5.5.2 (exposure mode 2). Other modes may be used by agreement, as long as the exact conditions are detailed in the exposure report.

7.2 Exposure mode 1

Specimens are cycled through periods of UV exposure, followed by periods of no radiation during which temperature changes occur and condensation forms on the specimens, the periods being as specified in the referring standard. When no cycle has been specified, the following cycle is recommended:

> 4 h of dry UV exposure at a black-standard temperature of 60 °C ± 3 °C, followed by
>
> 4 h of condensation exposure, without radiation, at a black-standard temperature of 50 °C ± 3 °C.

NOTE 3 The predominant mode of degradation of some polymers, such as PVC, can be very sensitive to temperature. In such cases, it is suggested that a temperature lower than 60 °C be used to simulate cooler climates (e.g. 50 °C).

When selecting programmes of UV exposure followed by condensation, allow at least 2 h per interval to ensure attainment of equilibrium.

7.3 Exposure mode 2

Specimens are cycled through periods of water spray during continuous UV exposure, the periods being as specified in the referring standard. When no cycle has been specified, the following cycle with continuous UV exposure is recommended:

> 5 h of dry UV exposure at a black-standard temperature of 50 °C ± 3 °C and relative air humidity of (10 ± 5) %, followed by
>
> 1 h of water spray, with continued exposure to radiation, at a black-standard temperature of 20 °C ± 3 °C.

8 Procedure

8.1 Mount the test-specimen racks with the test surface facing the lamps. Fill all the spaces, using blank panels if necessary to ensure uniform exposure conditions.

8.2 Programme the selected test conditions and operate continuously through the required number of cycles. Interruptions to service the apparatus and to inspect specimens shall be minimized.

8.3 The exposure programme selected shall be by agreement between the interested parties and within the capabilities of the type of apparatus used.

9 Exposure report

Refer to ISO 4892-1.

Annex A
(informative)

Spectral distribution of radiation for typical fluorescent UV lamps

A.1 General

A.1.1 A variety of fluorescent UV lamps can be used for the purposes of exposure. The lamps described in this annex are representative of their type. Other lamps, or combinations of lamps, may also be used. The particular application determines which lamp should be used. The lamps discussed in this annex differ in the total amount of UV energy emitted and in their wavelength spectrum. Differences in lamp energy or spectrum may cause significant differences in the results of exposure. Consequently, it is extremely important to report the lamp type in the exposure report.

A.1.2 All spectral distributions of radiation shown in this annex are representative only, and are not meant to be used to calculate or estimate the total radiant exposure of specimens in fluorescent UV devices. Actual irradiance levels at the specimen surface will vary depending on the type and/or manufacturer of the lamp used, the age of the lamps, the distance to the lamp array and the air temperature within the exposure chamber.

A.2 Representative spectral irradiance data

The data given in table A.1 are representative of the spectral irradiance received by a specimen mounted in the exposure plane in an exposure chamber.

A.3 Lamp types

A.3.1 General

The spectral distributions shown in this section were measured using a spectroradiometer with a double-grating monochromator (1 nm bandpass) with a quartz cosine receptor. Sunlight was measured in Phoenix, Arizona (USA), at solar noon at the summer solstice with a clear sky, with the spectroradiometer on an equatorial follow-the-sun mount. The fluorescent UV spectral distributions of radiation were measured in the specimen plane at the centre of the specimen.

A.3.2 Type I lamps

A.3.2.1 For most applications, the wavelength spectrum of type 1 lamps is recommended. Figure A.1 illustrates the spectral distribution of one commonly used type I lamp compared to noon, summer sunlight. This lamp has a peak emission at 340 nm.

A.3.2.2 Another commonly used type I lamp has a peak at 351 nm, and is mostly used for behind-window-glass simulations. Its spectral distribution is illustrated in figure A.2. Note that lamps with different spectral distributions can produce very different results.

A.3.3 Type II lamps

Figure A.3 shows the spectral distribution for two common type II lamps compared to the spectral distribution of noon, summer sunlight.

Table A.1 — Irradiance at test specimen surface (in W·m^{-2})

Spectral band nm	**Type I** (340 nm peak)	**Type I** (351 nm peak)	**Type II** (313 nm peak)	**Combination**
< 270	0	0	0	0
270 to 300	0,1	0	5,2	0,3
301 to 320	3,0	0,8	13,1	3,0
321 to 360	25,1	22,6	12,1	22
361 to 400	11,0	12,7	1,1	18

NOTE — The data shown in this table are preliminary only. Additional work is under way in ASTM Committee G03, *Durability of non-metallic materials,* to develop more complete and technically valid data on irradiance specifications for fluorescent UV lamps.

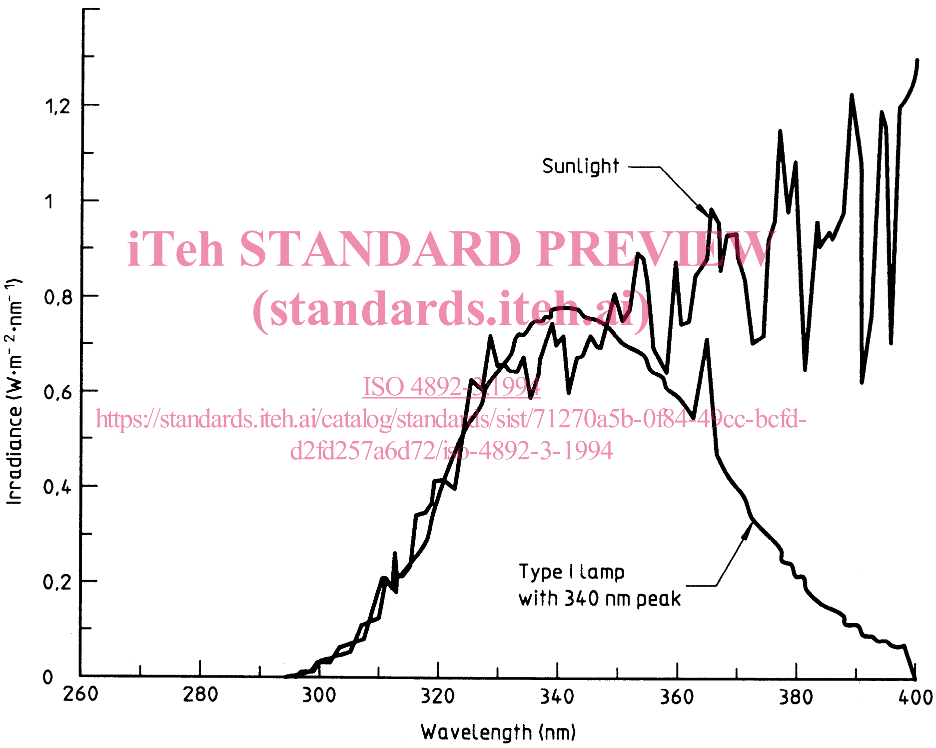

Figure A.1 — Type I lamp with 340 nm peak compared to sunlight

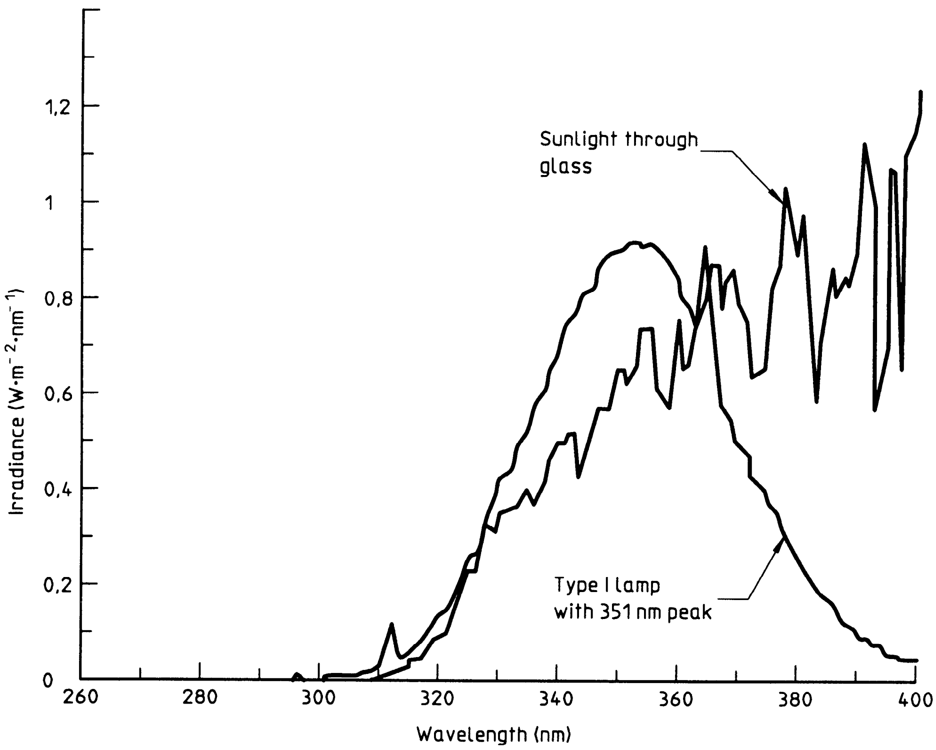

Figure A.2 — Type I lamp with 351 nm peak compared to sunlight through window glass

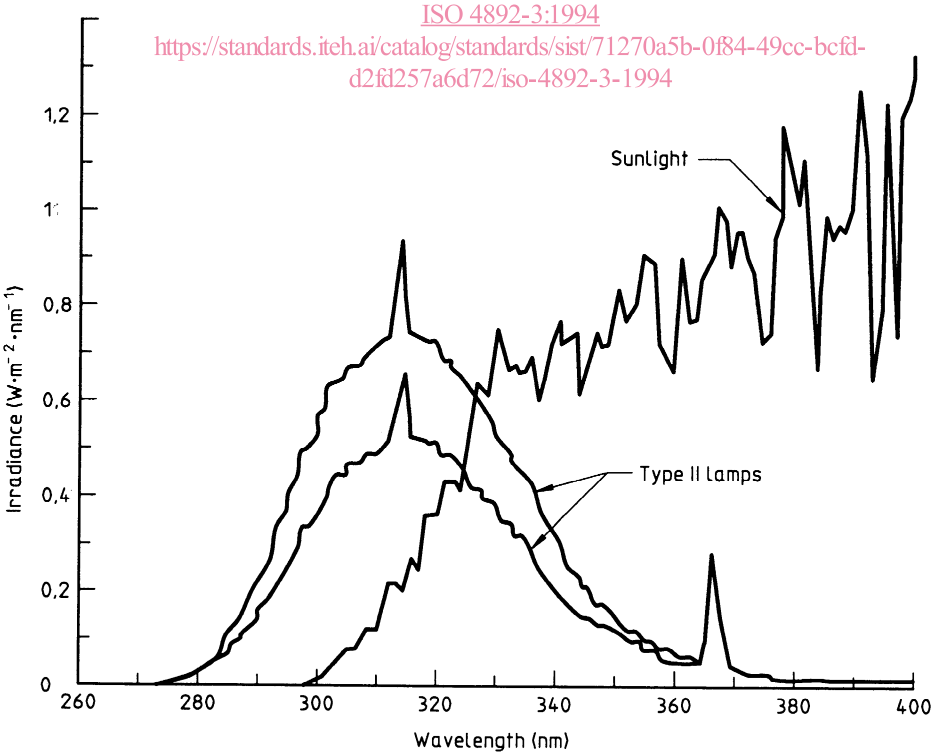

Figure A.3 — Typical type II lamps with 313 nm peaks compared to sunlight

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